International Journal for Parasitology: Parasites and Wildlife 2 (2013) 152–154

Contents lists available at SciVerse ScienceDirect

International Journal for Parasitology: Parasites and Wildlife

journal homepage: www.elsevier.com/locate/ijppaw

Current Opinion

Ten simple rules for describing a new (parasite) species

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ARTICLE INFO

Article history:
Received 27 November 2012
Revised 19 March 2013
Accepted 20 March 2013

Keywords:
Nomenclature
Description
Taxonomy
New species
Parasite
Illustration

ABSTRACT

Describing a new parasite appears to be a complicated task because it is regulated by objective rules of the International Code of Zoological Nomenclature. Here are practical rules that will aid you in writing a new species description and publishing it successfully. The ten simple rules expose commonly occurring challenges and aim to improve the awareness of requirements for species descriptions.

Introduction

The majority of the world's parasites remain unidentified and undescribed because of an alarming shortage of taxonomists, the disappearance of courses dealing with taxonomy and insufficiencies in funding. It is the priority of parasitological journals, including an online-only journal like IJP:PAW, to publish comprehensive species descriptions in an open-access format. Describing a new species can appear to be a complicated task that is regulated by objective rules of the International Code of Zoological Nomenclature (whether you like it or not). Either you do it correctly, and everyone congratulates you. Alternatively, you don't get it right and by the time such issues emerge, your work is published, you cannot retract, and either you or someone else will need to deal with the consequences. Here are a few pointers noted over the years that should enable you to make the description a success. The "Ten Simple Rules" (Bourne, 2005) format is used because it provides a simple tool to expose commonly occurring challenges that researchers are facing, together with directions for solutions.

Rule 1: Start with an optimal specimen

Every new species description has to have a specimen – real physical material that you are describing. This specimen is forever the name bearer and therefore the international standard of reference. New species are usually represented by more than a single specimen; it is the multiple specimens that you must consider as forming the new species, but the new name is linked to a single specimen. Your duty is to work through the specimens and then, based on your knowledge, select the specimen that optimally represents the new species. The specimen will become known as the type, also known as the holotype or hapantotype (**Rule 2** will help you to decipher the jargon associated with the new species description). Specimens used for description need to be deposited in publicly available repository (e.g., museum, culture collection). For living cultures, a cryopreserved sample should be deposited to avoid genetic modification.

Rule 2: Get familiar with the jargon – don't mix nomenclature with species concepts

Nomenclature is a system of naming of species, which are then classified in an ordered system – taxonomy. Nomenclature covers the rules how names are formed. These rules are mandatory and are defined by the International Code of Zoological Nomenclature (ICZN, 1999) or the International Code of Nomenclature for algae, fungi, and plants (ICN, 2012). The rules are objective. If you plan to describe a parasitic species you should, in the majority of cases, be familiar with the ICZN code. Don't expect that all will be clear at first. For now, read the introduction of the ICZN and be familiar with the glossary (http://iczn.org/). The specimens used for the description, apart from the holotype, are called paratypes. If males and females occur, then the equivalent of the holotype (usually but not always male) is the allotype. For single-celled organisms (protists), selecting a single specimen can be very tricky and often

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2213-2244
http://dx.doi.org/10.1016/j.ijppaw.2013.03.005

virtually impossible. Therefore, a preparation of life cycle stages or a culture of more than one individual is used and termed the hapantotype. This hapantotype is then the holotype of a protist species. One key issue is not regulated by the ICZN – it is what constitutes a species itself. There are many species concepts that are competing for general acceptance.

Rule 3: Aim high – the new species deserves it!

Know the standard of description. Prepare the best description you can, don't omit an analysis if it has been used in the past for species in a genus to which you are adding an undescribed species. Know your organisms, in other words, make sure you have done your homework and have collected all the previous published descriptions within the genus (more on older species and names in **Rule 4**) and, if possible, examined type specimens. Avoid tunnel vision, know the standard for new species descriptions in at least two related groups of organisms and learn from it. Don't limit yourself to the usual standard of descriptions which characterise the group in which you may be working. These standards are subjective and tend to change over time.

Rule 4: All previously described names must be considered

Even poorly described names that meet the minimal ICZN criteria (e.g., published description) have to be considered and cannot be ignored *a priori*. Absence of type material does not mean the name and species do not exist. Only a name that lacks a description or definition is *nomen nudum* (a naked name).

Rule 5: State why you are describing a new species

Publishing simply for its own sake should be avoided. New species are not hard to find, but making sense of the evolution and degree of diversity should be your aim. Understand the ecological role of the species and, in the case of parasites, relevance to animal or human health should be examined before the species is named. Practice by explaining to your colleagues your reasoning before you write the first draft. Then review and write it again.

Rule 6: Send your description to a journal that will make your description visible to your audience

Pick a journal that has a history of publishing taxonomical works. Study the author instructions; see if they welcome taxonomical works. Some do, some don't and some do if the new species is of some significance. You can choose any journal to publish your description, no matter if it is an online-only journal (Zhang, 2012; ICZN, 2012). But if you do use an online-only journal, you are required to register the new name in ZooBank (http://zoobank.org/). The new name must appear for the first time in a formal publication. Journal publication is the only acceptable channel for introducing new species and names. In the great majority (if not all) of instances, conference abstracts or PhD theses are not suitable for this purpose.

Rule 7: Don't put the cart before the horse!

Don't rush with your description, which should be the culmination of your work – not the start. Treat your work with extreme care. If you can analyse additional feature(s), then do so. Sequels to descriptions should be avoided as journals are not interested in publishing such material. Treat data equally. It is increasingly common these days to use DNA data as traditional work is considered too "complicated", too labour-intensive, or difficult to do at the level of quality the species deserves. Do that extra work, because the "complicated" part, i.e. comparative morphological and ecology, often leads to a reward, namely that you will be greatly respected by your colleagues, reviewers and journal editors.

Rule 8: Use illustrations and photographs effectively

Descriptions always come with illustrations of the holotype as well as allotype (if known) of new species. Use illustrations to demonstrate characteristic features of the species and those features that characterise the group to which your new species belongs. In addition to holotype (and allotype), other specimens in the type series can be used for illustrations. Photographs of specimens are useful in any description, but these need to be of the highest quality. Photographs can be presented as a series accompanying your illustration; often scanning electron microscopy (SEM) or differential interference contrast light microscopy (DIC) are used. Remember, naming a new species is evidence-based research. If you're describing a key feature, then you need to demonstrate it using a photograph or line drawing. It is the role of the reviewers and journal editors to scrutinise the evidence. In some circumstances, e.g., large nematodes and cestodes, line drawings are the most appropriate ways to document a holotype rather than a photograph. In other circumstances, e.g., blood parasites, a photograph of a stained blood smear is accompanied by a line drawing of a hapantotype. In this case, the photograph serves not only for the purpose to document a type but also its type locality.

Rule 9: Tell the world how to objectively differentiate your new species from other similar species

Once you have selected your holotype (**Rule 1**), described type series (**Rule 3**), photographed and illustrated the new species (**Rule 8**), you are required to provide information to distinguish it from other species represented by other specimens. The new species is placed in the correct genus and differentiated from other species (ideally all) within the genus. This is provided in the compulsory remarks, or differential diagnosis, section of the manuscript introducing new species. The remarks should serve a purpose as outlined in **Rule 5**. The approach you take should be inclusive of species you consider in your comparative work, not exclusive. For example, the use of DNA analysis, if no other related species has been characterised, is not sufficient. You will need to first demonstrate the within-species DNA diversity and characterise the same DNA marker(s) for related species to argue that between species DNA diversity differentiates your new species. You can use second-hand DNA data in the DNA repositories, but be wary of the quality because only the submitters are responsible for quality control (Harris, 2003). As with the DNA, treat the type locality cautiously; objective differentiation should be based on evidence, not an assumption. The type locality for parasites is not just the geographical place of capture of the type host, but also the type host species itself and the host tissue parasitised. Exercise great caution and rule out the possibility that the parasite has not been acquired elsewhere. It is worth noting that not all of what is in the gastrointestinal tract and resembles a parasite is the host's parasite, because parasites of their prey may pass intact through the gastrointestinal tract. For captive hosts, the new parasite could have been acquired during transport or even at the final destination because monitoring and quarantine measures during the import/export of live animals may be weak or absent. Last but not least, naming the type host using its common and scientific name should be mandatory and,

if possible, the type host specimen (*symbiotype*) should be deposited in a museum.

Rule 10: Give a memorable name

Don't be afraid to find a colleague who has some knowledge of Latin or Greek to help you with the selection of a new name. The formation of new names is governed by the rules of Latin grammar, so talk to someone who is familiar with basics of this grammar. Not all editors or reviewers know enough Latin or Greek to correct errors for you. It is your role to get this right. Avoid the embarrassment of naming it incorrectly; unfortunately fixing incorrect names later is very cumbersome. Make it right the first time. Last, but not least, etymology should be mandatory – explain how you derived the name and what it means. The name you choose is up to you, but make it simple and don't be afraid to use a characteristic feature of your species as the name (Sangster and Pope, 2000).

Acknowledgements

I thank Ian Beveridge and David Modrý who provided expert advice and feedback on the early drafts of the manuscript.

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